

Research on the Development Path of China's New Energy Power Market Trading

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Abstract: With the new energy power gradually get rid of the subsidy dependence and the power market construction is promoted, China needs to clarify the competitive power market environment and implementation path for renewable energy to participate in the transaction as soon as possible. New energy power transactions based on the summary of competitive power market, on the basis of international experience, analyzes the current progress and future prospect of the construction of the competitive power market, points out that to construct the effective competition market structure and market system, clear the top design and path electricity market mode, speed up the open generating electricity plan and user choice, standardize the spot market and ancillary services market, to sell electricity market reform and the wholesale market linkage. Finally, the path of promoting China's renewable energy generation to participate in the competitive electricity market is put forward.

Keywords Renewable energy; Competitive electricity market; Market transaction

INTRODUCTION

Long-term since, our country electric power market construction is slow, especially the lack of market mechanism, the market-oriented pricing mechanism has not yet fully formed, including new energy power feed-in tariff of all kinds of electric power and power generation plan shall be formulated by the government guidance or, power construction investment is still the continuation of scale expansion development road, power system flexibility and failed to give full play to the potential resources of the market value [Lin *et al.*, 2019]. As wind power, photovoltaic and other new energy power will gradually get rid of the dependence on subsidies after 2020 and enter the stage of high proportion development, China must clarify the environment and road for the market-oriented development of new energy power as soon as possible.

At present, China's electricity system reform has shifted from "top-level design" to implementation, and all eight pilot spot electricity markets have carried out settlement and trial operation [Xia *et al.*, 2020]. However, the model of electricity market and the participation of renewable energy power in market transactions still need to further clarify the top-level design and implementation path [Chen, 2019]. Therefore, this paper summarizes the mature electricity market environment, trading mode and trading approach of renewable energy in Europe and America. This paper summarizes and evaluates the construction objectives, ideas and progress of China's electricity market, and discusses the basic conditions, market subjects, participation paths, market tools and risk countermeasures for China's new energy and

renewable energy to participate in electricity market transactions.

INTERNATIONAL EXPERIENCE IN NEW ENERGY POWER TRADING IN COMPETITIVE ELECTRICITY MARKETS

Competitive electricity market

Since more and more countries have promoted the market-oriented reform of the power sector in the 1990s, most of the power systems in Europe and the United States have implemented the "competitive market" model, such as Northern Europe, Germany, France, Australia and the PJM, Texas, New York, California, New England and other major power markets in the United States. At present, competitive electricity markets tend to be hybrid. System Operators have unified responsibility for running the spot market and ancillary services market to address system imbalances. The generating units submit bids to the market organizer and operate online according to the generation plan uniformly arranged by the system operating organization. At the same time, generating sets can freely sign off-market bilateral contracts with electricity selling companies or electricity users to deal with market risks.

Transaction mode and support mechanism of renewable energy in competitive electricity market

At present, countries with relatively large scale of new energy power generation have established competitive electricity markets. In addition to the mandatory grid acquisition and Fixed-in Tariff program, renewable energy generation can participate in over-the-counter bilateral contracts, day-market

and day-market. Some markets are also exploring the possibility of new energy participating in the ancillary services market through redundant capacity and operational strategies. When renewable energy power generation enterprises participate in different electricity market conditions and trading modes, their profit methods, profit prospects, market risks and other aspects will change significantly.

System balance mechanism and responsibilities

Spot market plays an important role in connecting market transactions with physical operation. From the operation practice of foreign main power markets, the transaction scale of spot market can account for 30%-80% of the total transaction volume of the power market, which mainly occurs in the day-ahead market. The intraday market, whose main role is to fine-tune the generation and consumption plan, and the real-time market, whose main role is to ensure the real-time balance of the system, are relatively small, about 1-2% of the total trading volume [Wu *et al.*, 2019]. With a large number of intermittent new energy access, intra-day market can provide institutional support for new energy to participate in market competition.

In order to maximize the expected revenue of wind power companies, some countries have studied the bidding strategy of day-ahead market, the joint bidding of wind power and energy storage, the joint bidding of multiple wind farms and other strategies. Some research results show that wind power has a good frequency modulation performance, participate in the frequency modulation market economy; Wind power can also purchase reserves from conventional power sources through bilateral reserve markets to minimize balance losses.

PROGRESS AND PROSPECTS OF THE CONSTRUCTION OF CHINA'S COMPETITIVE ELECTRICITY MARKET

The goal of electricity market construction is to build an effective competitive market structure and market system

Slowly for a long time, China's electric power market construction, electricity, and sending plan shall be formulated by the government guidance and use of electricity, especially lack of trading mechanism, electricity sales mechanism of effective competition has not yet been established, market transactions between power enterprises and users is limited, market-oriented pricing mechanism has not yet fully formed, the traditional electric power in vulgar development road, expansion of scale management pattern, makes the new energy and renewable energy development and utilization of facing difficulties. It is widely recognized that without comprehensively deepening the reform of the power market and establishing an effective modern power market system, it will be difficult to promote the transformation of the development mode of the

power industry and the optimization of the power structure, and it will be difficult to continuously increase the proportion of renewable energy generation and distributed energy system generation in the power supply.

Since 2015, a new round of electricity reform has entered the implementation stage, with greater attention paid to the establishment of a modern market system and the formation of new driving forces and institutional guarantees. The goal of the Opinions on Further Deepening the Reform of the Electric Power System is to build a market structure and a market system with effective competition, and to form a mechanism whereby energy prices are mainly determined by the market. According to the Opinions on the Implementation of Promoting the Construction of the Electricity Market, regions where conditions are met will gradually establish a market-based electricity quantity balance mechanism with medium - and long-term transactions as the main part and spot transactions as the supplement, so as to form a power market with a full range of transactions and complete functions, in which risks can be avoided through medium - and long-term transactions, prices can be found on the spot market, and prices can be found on the spot market.

The top-level design and implementation path of the electricity market model still need to be further defined

At present, China's power system reform has shifted from "top-level design" to implementation, and the construction of the power market has been first experimented by provincial governments in accordance with their administrative jurisdiction. However, the current reform is still mainly the reform of management system, the design of power market system is still not perfect, the construction of competitive power wholesale market is still in exploration, and there are differences in the selection of market model and the design of trade varieties. At present, "direct trading" with the expected goal of lowering electricity prices is widely implemented across the country. In 2018, market-based electricity trading accounted for about 30 percent of the country's total electricity consumption. However, if the goal is to promote the optimization of power supply structure and improve system efficiency, the spot market and balance mechanism must be established, otherwise it is difficult to be sustainable. Without the construction of competitive electricity wholesale market, the new round of electricity marketization reform will still become empty talk.

According to the current trend of power reform, most regions in China are expected to establish provincial power wholesale markets first, but should promote the establishment of regional competitive power wholesale markets in the future, the central government should be responsible for the construction of power wholesale markets, and local governments should be directly responsible for the

retail market. And, also need to be further clear, including renewable energy, all kinds of electric power in the premise of market transactions, implementing path and access mechanism, the bidding period, clearing mechanism, pricing method, the settlement mechanism, the deviation of punishment, subsidies and other specific market rules, and establish appropriate to the ancillary services market, realization mechanism of various factors on the medium to long term, a few days ago, real-time timing of close coordination, effectively stimulate the enthusiasm of the market main body [Liu *et al.*, 2020].

The focus of medium-term and long-term transactions is to accelerate the development of power consumption plans and user options

Medium-term and long-term transactions in China are mainly represented by direct transactions by large users, but have recently begun to expand to include more generation and power users. In accordance with the "about promoting trading of electricity market, further perfecting the mechanism of the notice requirements, in addition to the eight electricity spot market pilot areas can send electricity according to the practical design plans to reform path, most of the partition according to the power category and gradually put the user scale development utilization plan, expand the scope of market main body, a substantial increase in electricity market trade.

At present, provincial governments generally guide all kinds of power generation plans and direct transactions by large users, strictly control the power purchased by the province and intervene in the transaction price. In the future, the key is to reduce undue administrative interference by local governments and to develop electricity plans and users' options. On the one hand, the province should release the development of electricity plans and users' options. The coal-fired power units approved after the promulgation and implementation of Document No. 9 will no longer be arranged to generate electricity, and the power generation plans of coal-fired power plants should be gradually reduced or canceled. On the other hand, the inter-provincial barriers should be broken, the core of which should also be the development of electricity plans and user options, local market entities should be removed from the cross-provincial and cross-regional transactions, inter-market transactions restrictions, allow power sources to choose the grid independently.

Standardized spot market and ancillary service market are the key tasks in the future

In the early stage of direct electricity purchase by large users in China, the transaction scale is usually small, and its influence on the dispatching operation of the power grid and the transaction organization of the power market is also small, so it can be simply executed by physical delivery. As the user directly trade scale expands unceasingly, facing challenges on

power balance, the root cause is the long-term bilateral trading market and the contradiction between "spot trading" non-market increasingly highlight, in trading cohesion and load of power grid, new energy given, power generation plan execution, congestion management, real-time balance various aspects, such as need to establish a long-term trading and spot trading as soon as possible with the combination of full electric power market system, make the spot market for medium and long-term trading and short-term physical operation of the important role, and affirmatory bilateral transaction price for the market members to provide the reference signal.

(1) Prioritize the construction of the day-ahead market and gradually transition to the construction of the real-time market; For intra-day market, priority should be given to market areas with high proportion of intermittent power such as wind power and photovoltaic power, so as to provide institutional support for new energy to participate in market competition.

(2) Take measures according to local conditions, adopt partial electric quantity and full electric quantity spot mode. At present, China's electricity trading is dominated by planning, with some large users trading directly. The partial electricity spot mode is easier to connect with the existing mode. For provinces with a high proportion of new energy and a small market power, the full electricity spot mode can be explored. The State Grid Corporation of China has explored the spot trading of "surplus" new energy power, which is essentially the spot trading of the tie-line of part of the power.

(3) Encourage large users to sign financial contracts for direct electricity purchase, and conduct financial settlement for deviated electricity quantity (according to the spot market price), so as to include direct electricity purchase contracts in the unified clearing calculation of the spot market.

(4) Expand the scope of spot market. At present, it is notified that the pilot construction of electric spot market should in principle be organized and carried out according to the existing electric power dispatching and control areas (considering trans-provincial and trans-regional power transmission and receiving), and regions with conditions can actively explore the merger of dispatching and control areas. Referring to the trend and experience of power market connection in Europe and the United States, in order to realize the evolution to the future inter-provincial power market system, the core rules of provincial spot market should be unified as far as possible at the beginning of the process.

(5) The current so-called auxiliary service market with peak regulation as the core should be changed, the spot market and auxiliary service market of electric energy should be built simultaneously, and the synchronous optimization and joint clearing of the electric energy market and auxiliary service

should be promoted in the spot market [Chen *et al.*, 2016].

The reform of electricity sale market needs to shift from direct electricity purchase by large users to linkage with wholesale market

The new round of electricity reform allows qualified power generation enterprises to invest and set up electricity sellers to enter the market, thus building a competitive pattern of diversified electricity sellers. At present, China is actively promoting the construction of the electricity sales side market with the direct purchase of electricity by large users as the breakthrough point. However, the premise of the competition on the electricity sale side is the competition in the wholesale market. In the mode of power store, the sellers only compete in the retail end, that is, in the scope of fighting for end-users. In the mode of "bilateral transaction", the selling e-commerce companies should not only participate in the retail competition, but also participate in the wholesale competition. Therefore, the key to the reform of the electricity sale market is to promote the linkage between the electricity sale market and the competitive wholesale market, and to design the overall reform of the electricity sale side and the wholesale market model. In addition, users' right to choose should be guaranteed. For example, all types of electricity with verified transmission and distribution price can participate in the electricity market trading with full power supply, enterprises in various parks can participate in the electricity market trading with bundled agents of electricity sale companies, and local power grids can participate in the electricity market trading as a whole.

EXPLORE THE PATH FOR CHINA'S RENEWABLE ENERGY GENERATION TO PARTICIPATE IN THE COMPETITIVE ELECTRICITY MARKET

Gradually promote the participation of renewable energy in competitive electricity market transactions

In recent years, the scale of new energy in China has increased rapidly, but the challenges of grid connection and consumption are prominent. In competitive electricity market, grid connection is the problem of technical standard and market access opening, and consumption is the problem of market subject transaction and system flexibility. The result of electricity market clearing according to the principle of lowest system cost is the balance of supply and demand. Therefore, the purpose of renewable energy power to participate in market trading is to guide the market participants' trading through the electricity market, release the flexibility of the power system, and more effectively run renewable energy and all kinds of power sources to meet the electricity demand.

According to the construction of power market and the development process of new energy power, China should push the new energy enterprises to gradually transform into the main body of competitive power market. In addition to hydroelectric power plants, large wind and solar farms, distributed wind and distributed generation investors are expected to be the major players in the new energy power market, while new energy microgrid owners are expected to be more innovative in terms of market models and transaction mechanisms. In accordance with the relevant provisions, as a new energy micro grid operating subject distribution rights to sell electricity company should be liable within the micro grid power supply service, responsible for the power exchange of micro power grid with external power grid, and the internal and external users do sell electricity business, establish 购售 both parties to negotiate the price system, even build cold, heat, electric energy resources market trading system. New energy microgrid also participates in ancillary service transactions as an independent ancillary service provider.

It is urgent to embed priority generation and guarantee acquisition system into medium-term and long-term transaction rules

At present, the urgent task is to make a good connection between the priority generation system and the power market rules. Under the priority generation system, the priority generation and guarantee acquisition system should be embedded in the medium and long term trading rules, and the priority power purchase and priority power generation should be regarded as annual electricity energy transaction and signed contracts. Priority renewable energy generation contracts are transferable. We should also encourage the transfer of preferential electricity purchase contracts across provinces and regions, and promote the consumption of renewable energy across provinces and regions. In addition, the auction mechanism of renewable energy projects can also be regarded as the capacity purchase mechanism in the electricity market.

Recent renewable energy actively participates in medium and long term transactions inside and outside the province

China needs to further liberalization of hair inside and outside the province electricity planning and user choice, guide to promote power users and hydropower, wind power, solar power and other clean energy power generation enterprises to carry out market transactions, let go of the provincial power grid company and power users and sell electricity enterprise outsourcing electric power in the province, and put the renewable inter-provincial trade into priority transmission channel capacity. At present, many pilot schemes of electric power reform propose to promote the absorption of renewable energy through power generation right trading and

alternative power generation. However, it should be pointed out that at present, the so-called "power generation right transaction" and "substitution transaction" of coal power enterprises transferring planned electricity to new energy enterprises in some regions are the products of coal power enterprises enjoying planned electricity, and should lose the foundation along with the gradual release and development of electricity plan and cancellation of planned coal power. In addition, power grids should serve new energy transactions, allow inter-network cooperation between local power grids and power grids in neighboring provinces, encourage direct trans provincial and inter-regional net-to-network and net-to-point transactions, support point-to-network and point-to-point direct transactions in an orderly manner, and promote large-scale consumption of clean energy.

Medium-term renewable energy can explore and participate in the spot market

In mature electricity markets in Europe and the United States, spot electricity markets provide flexibility for renewable energy and a crucial way for new energy generation to participate in the electricity market. Referring to international experience, new energy enterprises can directly participate in the spot market, and the government can reduce investors' risks through two modes of contract for difference and market premium in the near and medium term. One is the contract for difference model. New energy power generation enterprises sign price difference contracts with designated agencies of the government or power grids according to the bidding price, and participate in the spot market of power on an equal basis. If the market price is lower than the benchmark price, the shortfall will be paid by the government or consumers; On the contrary, new energy enterprises return excess earnings. The second is the market premium model. New energy power generation participates in market competition with other units in accordance with the same rules, and will receive a certain proportion of subsidies based on market prices. The subsidy can be a fixed value or can be adjusted according to fluctuations in electricity prices. In the future, as the technology matures and the cost of renewable energy decreases, the subsidy intensity can also be gradually reduced, so that renewable energy will be fully market-oriented and eventually withdraw from the subsidy policy.

Establish market-based trading and risk response mechanisms simultaneously

Combined with the construction process of China's electricity medium - and long-term trading, spot market and financial futures market, renewable energy power can also explore the following market-based risk response modes. Mode 1: Renewable energy power and power users sign a financial contract for price difference, and then participate in the electricity wholesale market bidding. The

electricity user pays the difference between the actual market price and the agreed price to the renewable power supplier. Mode 2: Renewable energy power directly participates in the bidding of electricity wholesale market and buys hedging.

Explore the distributed generation market on the electricity sale side

Distributed generation represents a new direction and a new form of energy development. However, the analysis of distributed generation and energy storage on the huge impact and reconfiguration of the future power market is insufficient. Factors such as micro-grid and incremental distribution network have exploded. More distributed transactions can help large power grids to solve the problems of power balance and price fluctuation risk, and even change the original market construction path. Therefore, more research and exploration are needed in the future.

CONCLUSION

New energy power transactions based on the summary of competitive power market, on the basis of international experience, analyzes the current progress and future prospect of the construction of the competitive power market, points out that to construct the effective competition market structure and market system, clear the top design and path electricity market mode, speed up the open generating electricity plan and user choice, standardize the spot market and ancillary services market, to sell electricity market reform and the wholesale market linkage. Finally, the path of promoting China's renewable energy generation to participate in the competitive electricity market is put forward.

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